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Neutron Scattering of CeNi at the SNS-ORNL: A Preliminary Report

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ABSTRACT

This is a preliminary report of a neutron scattering experiment used to investigate 4f electron behavior in Ce.

INTRODUCTION

The manifestations of electron-correlation in Pu and Ce have interesting parallels [1], including large volume collapses between phases. [2,3] CeNi, using Ni 60 to minimize the Ni magnetic scattering [4], was chosen as an avenue to probe the magnetic cancellation in Ce. This magnetic cancellation should be of the Kondo type, with the valence electrons screening the f electron moment. [5-7] This screening should change under pressure. [8,9] The neutron scattering experiments [10] were carried out at the Spallation Neutron Source [11] at Oak Ridge National Laboratory, using the Sequoia Facility. [12]
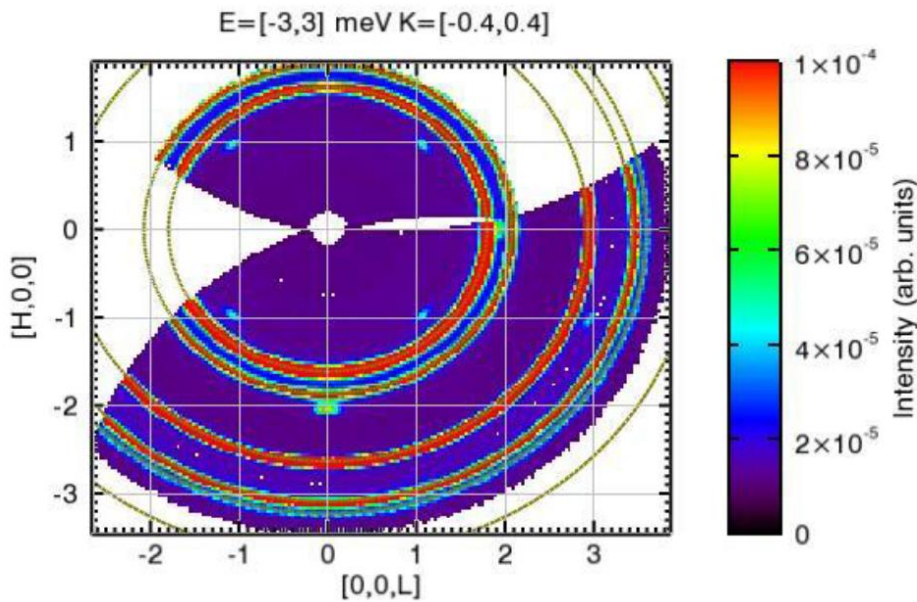
EXPERIMENT and DISCUSSION

Figure 1: An example of scattering data from CeNi. The pie-slice-shaped sections are derived from rotation of the sample. The distortions away from linear cuts are due to the conversion from angle to momentum.

Pulsed neutrons are generated by the acceleration of protons into a target. The pulsed neutron beams are scattered off of the samples in various beam-lines. In the Sequoia Beam-line, a large area, position sensitive detector collects the scattered neutrons. Energy analysis comes from time-of-flight, momentum from the combination of energy and angle in the position sensitive detector. Thus, the data collection is four dimensional: energy and three components of momentum. The sample can also be rotated about a vertical axis, permitting different angles of incidence. Data analysis involves summing over various angles and energies, providing cuts through the multi-dimensional data space, to permit 2-D and 3-D plots. An example is shown Figure 1. This data can then be symmetrized, an example of which is shown Figure 2.
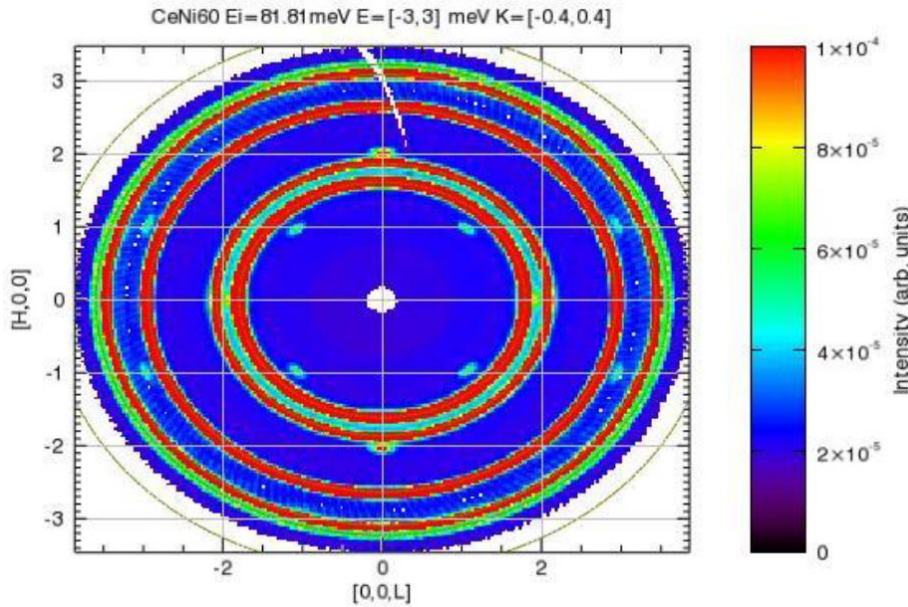

Figure 2: Scattering Data. The bright red and green rings are powder patterns from the polycrystalline Al of the pressure vessel. The individual spots are from the single crystal CeNi.

It is the energy loss that will provide a measure of the electron correlation. (Figure 3.) The data shown here is all at ambient pressure. Measurements at 400 Bar, 800 Bar and 2200 Bar suggest changes in the energy loss spectra. A sophisticated subtraction of the Al background must be done prior to a full analysis.
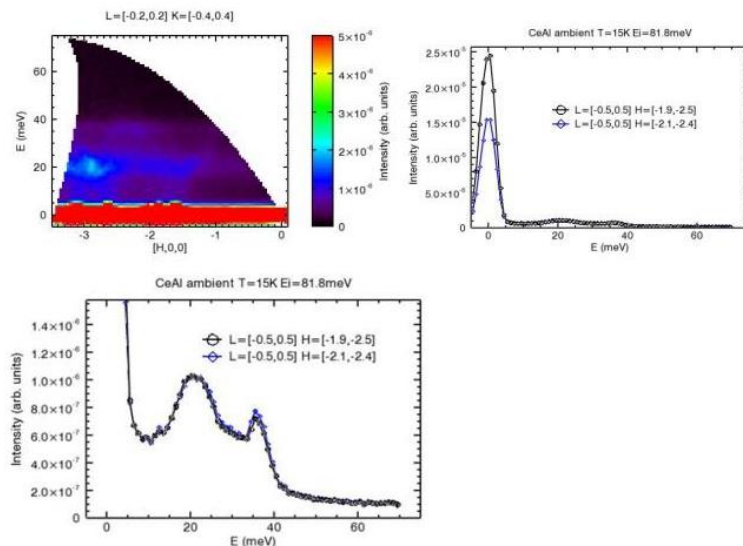

Figure 3: Data reduction to look at energy loss. Top left: Isolating a Bragg Scattering Peak of CeNi. Top right: comparing the Bragg Scattering peaks and energy loss for two peaks. Bottom: Blow-up of the comparison of the energy loss of two Bragg scattering peaks. The top label represents that the sample is CeNi in an Al sample holder..

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